THE VITAMIN A CONTENT OF THE YOLK OF HENS' EGGS

by

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INTRODUCTION

There is some discrimination in the eastern markets against eggs from the middle west which frequently have yolks of a deep yellow color. This appears to be essentially a dealer rather than a consumer preference, although there is also a demand by Jewish consumers for eggs of uniform light colored yolks. This discrimination results in a decided financial loss to the egg producers of the middle west. In connection with a cooperative project (Department of Poultry Husbandry, Chemistry Department and Department of Home Economics) for the investigation of this problem, it seemed desirable to study the vitamin A content of the egg yolk, often associated with color.

REVIEW OF LITERATURE

Eggs have been recognized as a source of the growth promoting factor, vitamin A, ever since this vitamin was first studied. In 1913 McCollum and Davis (1) reported that certain lipins are necessary in the diet during the growth of experimental animals. It was found that the ether extracts of butter or egg contain some organic complex without which the animals cannot make further increase in body weight but may maintain themselves in a fairly good nutritive state for

a prolonged period.

At about the same time Osborne and Mendel (2) reported that, on a ration containing 18 per cent egg yolk fat, rats grew from small size to adult proportions in the usual period. Growth continued for more than 300 days. Such a ration appeared to be adequate in every way for the continued nutritive needs of the species.

In 1924 Murphy and Jones (3) working on the vitamin A content of fresh eggs, found that the weight increase of rats receiving 0.1 gram of whole egg was nearly identical with that of those receiving 0.25 gram and not far below that of those receiving even 0.5 gram daily. The study revealed that about 0.25 gram of whole egg was required daily to cure rats of xerophthalmia, and 0.5 to 0.75 gram daily to restore normal weight. Since the yolks compose about 35 per cent of whole egg, 0.75 gram, 0.50 gram and 0.25 gram of whole egg would then be equivalent to 0.26 gram, 0.17 gram, and 0.088 gram, respectively, of yolk.

As reported by Bethke, Kennard, and Sassaman (4) in 1926, the fat soluble vitamin A content of the yolk of hen's egg is greatly influenced by the ration and by environment of the laying hen. Yolk of eggs laid by hens which had access to a blue-grass range were approximately five times as potent in vitamin A as the yolks of eggs laid by hens

which received the same basal mash but were confined indoors. The addition of alfalfa hay to the basal mash proved of some benefit in increasing the vitamin A content. The feeding of 2 parts cod liver oil in the mash accounted for an approximate five-fold increase in vitamin A content of the egg yolks.

Jones, Murphy and Moeller (5) reported that daily feedings of 0.25 gram of whole egg which had been stored for 9 years in a frozen condition were found to be as effective as fresh eggs in curing xerophthalmia. Even 0.1 gram daily caused noticeable improvement in the sore eyes, arrested the decline in weight of the animal and caused a moderate resumption of growth which lasted for 2 to 5 weeks.

Tso (6) stated that the chemical changes occurring in the Chinese preserved duck's eggs have little or no deleterious effect upon the stability of vitamin A. "Pidan" is made from raw duck's eggs, high in vitamins A, B, and D, by applying a mixture of slaked lime, straw ash, soda, table salt, and water.

Recently the Texas Agricultural Experiment Station (7) published results of the research of Sherwood and Fraps on "The quantities of vitamin A required by pullets for maintenance and for egg production." The estimation was made by feeding 3 groups of laying pullets daily an average of 270

units, 120 units or 0 units of vitamin A in yellow corn. In all 3 groups the vitamin A of the yolk of the eggs decreased from about 20 units per gram to 5 to 8 units toward the end of the 6½ month period, which shows that none of the pullets received sufficient vitamin A to maintain a high potency of the eggs. It was estimated that 1 unit of vitamin A in the egg required 6.3 units in the feed in addition to the maintenance requirements. The authors also suggested that laying pullets require green feed to provide sufficient vitamin A for maximum egg production and high vitamin A potency of the eggs.

Ellis, Miller, Titus and Beyerly (8) made observations on the vitamin A content of eggs produced in connection with vitamin B and G experiments. They wrote that the "vitamin A content of the eggs was maintained at a high level by the addition of cod liver oil . . . . although the basal diet of group B produced eggs which were low in vitamin B and strikingly deficient in the yellow pigments usually associated with vitamin A." No exact vitamin A content was reported.

Color and pigment studies were part of other phases of this project. However, it may be mentioned that carotene ($C_{40}H_{56}$) and possibly some other plant pigments are now usually associated with vitamin A, for which they serve as

precursors in the animal body. Moore (9) has reviewed important relationships of carotene to vitamin A, stating that carotene is synthesized in the plant, is intensely yellow, and gives a greenish blue antimony trichloride ($SbCl_3$) reaction at 5900 A^o while vitamin A is stored in the animal body, is almost colorless, and gives a blue antimony trichloride reaction at 6100-6300 A^o. He also found that in rats the liver fat becomes very rich in vitamin A after liberal feedings of carotene. Xanthophyll, an important yellow pigment in egg yolk, has been thoroughly discussed by Palmer (10). "The natural pigment characterized by the egg yolk, body fat, and blood serum of the hen is physiologically identical with the carotene and xanthophyll pigments of plants with the latter class of pigments present in by far the greater proportion. Feeding tests with laying hens in which the pigment of the feed was carotene to the relative exclusion of xanthophyll were without appreciable influence upon the amount of pigment carried by the blood serum and deposited in the egg yolk. The feeding rations relatively free from both carotene and xanthophyll to laying hens resulted in a marked reduction of the amount of this pigment carried by the blood serum and deposited in the egg yolk. The experiments reported find practical application in the control of the flesh (body fat) of fattening poultry, and the

control of the amount of natural pigment deposited in the egg yolk."

PROCEDURE

For these experiments vitamin A determinations were made according to the biological method of Sherman and Munsell (11). The modified A-free diet was used as follows:

	Original diet per cent	Modified diet per cent
A-free casein (extracted)	20	18
Starch	70 (irradiated)	67
Yeast	5	10
Osborne & Mendel Salt Mixture	4	4
Sodium Chloride	1	1
Viosterol	0	(as described below)

Vitamin A was removed from the casein according to Sherman and Munsell (11).

Squibb's viosterol, used to furnish the vitamin D in the diet, was fed as recommended by the U. S. P. and Druggists Committee (12). The amount fed was equivalent to 3 per cent cod liver oil, having a vitamin D value of 100 units per gram. The amount used, as calculated from the units as stated on the label, was 0.9 gram viosterol to 1000 grams food. The viosterol was dissolved in a small amount of

ether and added to the A-free casein. As other ingredients of the diet were added, each was thoroughly mixed to produce a homogenous product.

Albino rats of Wistar stock were used in this laboratory. The breeding animals were fed a diet suggested by Sherman and Crocker (13). It consisted of:

Dried whole milk	1/3
Ground whole wheat	2/3
Sodium chloride	2% of weight of wheat

The diet was fed ad libitum and animals had access to distilled water at all times. At 4 weeks of age the young rats were numbered and those weighing 35 to 53 grams were used in these experiments.

The Sherman and Munsell (11) A-free diet was used for the fore period as well as for the experimental period. During the fore period the animals were kept in cages with raised wire screen floors and were weighed at frequent intervals. The animal was started on experiment when it had failed to gain for a week or had developed xerophthalmia. Animals reaching 105 grams in body weight before depletion was complete were not used for these experiments.

After the depletion period litter mates were distributed among the experimental groups. The animals were fed separately in individual cages set up on raised screens.

Distilled water in sterilized jars was provided and at all times the animals had access to the A-free diet. Weighed, individual supplementary portions of egg yolk were fed in addition to the A-free diet, 6 days per week. Attempts were made to determine the amounts necessary to produce gains of 3 grams per week or 24 grams in 8 weeks, this being the unit of Sherman and Munsell (11). At the end of the experiment or upon the death of the animal autopsies were conducted and data included with other records.

The eggs used, together with the data concerning them, were provided by the Department of Poultry Husbandry. There were included eggs produced under experimental conditions as well as some purchased in the market for specific examination. The egg to be fed was placed in a double boiler containing water at 70° C. The egg was cooked for 18 to 20 minutes, the temperature not exceeding 90° C. When cool, the egg was peeled, the white discarded and the yolk mashed thoroughly so that individual portions would be uniform.

Eggs of four kinds (Table I) were used:

1. "Standard" eggs were produced by hens receiving the college poultry farm ration. Fresh standard eggs were always available for feeding.

2. "Light" eggs were produced by hens receiving a ration consisting of the following ingredients: white corn,

TABLE I

EGGS USED IN EXPERIMENT

Eggs produced in Manhattan - obtained fresh for feeding tests		
	"Standard"	"Light"
Ration of Hens	Commercial flock ration, Kansas State College Poultry Farm.	
	Scratch grain: (evening): Yellow corn -- 200 lbs.; Wheat ---------- 200 lbs.	Scratch grain - none used
	Mash mixture: White corn ---- 100 lbs.; Wheat ---------- 100 lbs.; Oats ---------- 100 lbs.; Meat and bone-scraps ------ 75 lbs.; Alfalfa leaf meal --------- 25 lbs.; Salt ---------- 4 lbs.; Cod liver oil- 1%	Mash: White corn ------ 70 lbs.; Dried butter-milk ---------- 20 lbs.; Ground wood fiber ---------- 4 lbs.; Dried brewers' yeast ---------- 3 lbs.; Cod liver oil -- 2 lbs.; Salt ---------- 1 lb.
No. Hens	400	4
No. Eggs Tested for Color and Flavor.	21	78
Yolk Color	Medium	Light or Pale
Yolk Hue	YR 10.89	Y 4.33 more yellow and less yellow red than the "Standard".
Flavor	1.64 (eggs less than 24 hrs. old)	1.56 (eggs less than 24 hrs. old)

TABLE I (CONTINUED)

Eggs purchased in New York City - kept in cold storage from time of receipt until used		
	"California"	"Kansas"
History: Origin	Petaluma, California	Linn, Kansas
Date gathered	About 3-1-1933	About 3-5-1933
" shipped East	3-4-1933	3-10-1933
" arrival, N. Y.	3-16-1933	3-15-1933
" purchased, N. Y.	3-17-1933	3-16-1933
" received, Manhattan	3-20-1933	3-20-1933
" feedings started	3-21-1933	3-21-1933
Wholesale grade Retail grade	U. S. #1 Extras A	U. S. #1 Extras A
No. eggs tested for color and flavor	3 or more	3 or more
Yolk Color	Medium	Dark medium "Golden yolked"
Yolk Hue	YR 10.97 - similar to the "Standard" egg	YR 7.5 - more yellow red than "Standard" and "California"
Flavor	1.69	1.66

70 per cent; dried buttermilk, 20 per cent; ground wood fiber, 4 per cent; dried brewers' yeast, 3 per cent; cod liver oil, 3 per cent; salt (NaCl), 1 per cent. Fresh eggs were used for the feedings.

3. "California" eggs were produced in Petaluma and were purchased in the open market at ware houses in New York City. The eggs were about 3 weeks old when first received for use and were held in storage during the experiment.

4. "Kansas" eggs, produced near Linn, Kansas, were also purchased in New York City. These eggs were of about the same age as the California eggs and were stored in the same way.

Questions concerning the pigments of the egg yolk and the effects of the ration of the hen on the color, flavor and pigments of the yolk were studied in other phases of this cooperative project. Color determinations were made by Wilhelm (14) according to the method of Nickerson (15).

DISCUSSION

Table I gives details concerning the eggs used in these experiments. The eggs produced in Manhattan were always obtained fresh (less than 24 hours old) for feedings. The eggs purchased in the open market were necessarily older, as indicated, and were held in storage at 40° F. until used.

The "Standard" eggs contained yolks which graded medium in color. The "Light" eggs, produced by hens receiving a ration low in pigments, contained yolks which graded light in color.

The eggs purchased in the open market were of high grade, as indicated. The "Kansas" eggs contained yolks of uniform medium color, darker than the "California" eggs. The "California" eggs were light and showed some range in color of yolk.

No eggs used were of poor flavor, all yolks grading between 1.50 and 2.00. The figures were used as follows:

1.00 - Perfectly fresh egg (less than 1 hour old).

2.00 - Egg yolk slightly "off" in flavor.

3.00 - Egg yolk distinctly "off" in flavor.

4.00 - Egg with bad flavor.

5.00 - Rotten egg.

The average scores of the judges (another phase of the cooperative project) revealed only small differences between the four groups of eggs tested. Averages are given in Table I.

Tables II to IX give data concerning experimental animals fed weighed portions of the yolks of the eggs. Average figures for body weights at weekly intervals were computed in the usual way. Emphasis was placed on average live

TABLE II

RATS ON VITAMIN A-FREE DIET PLUS 0.01 GRAM TOTAL OF "STANDARD" 200

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7267 L	39	24	79	92	88	101	98	96	85	77	82	56
7339 R	36	40	100	95	75	83	82D					22
7298 B	42	33	93	96	101	97	90	86D				32
7297 Le	51	33	102	111	120	119	115	92	92D			37
7287 RR	44	30	95	99	106	112	107	100	95	89	77	56
7299 RR	36	19	66	83	87	92	100	100	102	91	72D	55
7241	43	26	85	93	97	99	99	103	104	107	106	56
Average	41.6	29.3	86.6	95.6	96.3	97.6	95.9	97.7	95.6	91.0	85.6	45
Average--live wt.			88.6	95.6	96.3	97.6	101.5	100.0	96.5	91.0	85.0	

D - died.

TABLE III

RATS ON VITAMIN A-FREE DIET PLUS 0.02 GRAM YOLK OF "STANDARD" EGG

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7239 L	41	25	80	89	92	92	94	99	96	95	91	56
7266 R	36	23	83	97	95	105	109	107	103	94	90	56
7260 L	36	31	80	84	86	86	85	87	76	80	61D	55
7294 B	45	33	88	96	96	100	106	106	101	88	80	56
7288 B	43	34	101	115	124	136	136	136	134	123	118	56
7260	30	38	100	96	97	96	95	86	65D			36
Average	40.3	30.7	88.7	95.8	98.4	102.5	104.1	103.5	96.8	92.0	89.6	53
Average - live wt.			88.7	95.8	98.4	102.5	104.1	103.5	102.0	92.0	96.8	

D - died.

TABLE IV

RATS ON VITAMIN A-FREE DIET PLUS 0.03 GRAM YOLK OF "STANDARD" EGG

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7303 B	40	32	94	107	115	92	86	80	71D			36
7304 R	38	32	86	116	119	116	117	112	101	82D		46
7490 L	35	37	103	91	96	104	106	111	106	102	109	56
7495 R	36	37	90	95	93	92	94	91	90	103	103	56
7497 L	53	35	105	109	111	116	123	117	114	113	110	56
7494	36	42	100	90	93	96	88	76	90	87	75D	55
7308 B	39	32	94	102	117	121	123	115	90D			41
7306 R	41	32	91	102	118	121	117	92	90D			37
7230 R	47	25	99	119	126	130	122	140	140	142	141	56
7242 R	42	25	81	96	98	97	100	106	115	117	116	56
7549 RR	41	25	72	81	82	79	78	79	80D			39
Average	40.7	32.0	92.0	99.9	105.6	105.0	105.0	101.7	99.0	107.4	109.0	48
Average - live wt.			92.0	99.9	105.6	105.0	105.0	101.7	109.3	105.0	115.8	

D - died.

TABLE V

RATS ON VITAMIN A-FREE DIET PLUS 0.02 GRAM YOLK OF "LIGHT" EGG

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7470 R	40	29	89	99	104	102	105	98	95	94	91	56
7468 B	45	37	103	106	107	110	115	108	107	106	102	56
7480 B	41	35	98	100	106	102	81	75	73D			40
7459 L	50	35	104	106	113	114	116	116	116	124	120	56
7462 Bu	42	35	103	110	116	115	114	122	102	116	113	56
7471	47	29	101	108	116	116	111	109	100	103	103	56
7449 L	41	43	103	101	100	92	92	74	78	73D		47
7452 R	39	43	99	96	102	103	105	99	94	89D		45
Average	43.1	35.8	100.0	103.5	107.8	106.6	104.4	100.5	95.6	100.7	105.8	52
Average - live wt.			100.0	103.5	107.8	106.6	104.4	100.5	96.8	100.6	105.8	

D - died.

TABLE VI

RATS ON VITAMIN A-FREE DIET PLUS 0.03 GRAM TOLK OF "CALIFORNIA" EGG

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7563 L	35	28	93	97	88	86	87	70	62D			39
7646 LL	40	27	77	74	75	78	83	82	87	79	80	56
7643 R	44	27	87	90	83	94	93	96	93	98	99	56
7565 R	40	26	90	95	102	107	110	108	110	102	102	56
7573 R	44	33	100	112	109	106	108	92	87D			37
7567	50	32	97	106	107	116	111	114	106	109	105	56
7602 Rs	40	28	90	97	96	96	102	100	98	97D		43
7640 R	37	29	70	80	85	85	80	76	71	85	80	56
7638	40	32	98	98	89	92	87	89	93	72D		47
7636 B	50	28	100	96	85	82	70	66D				32
Average	42.9	29.0	91.1	92.9	91.9	94.2	93.1	89.3	89.7	91.7	93.2	48
Average - live wt.			91.1	92.9	91.9	94.2	93.1	91.9	94.0	94.6	93.2	

TABLE VII

RATS ON VITAMIN A-FREE DIET PLUS 0.04 GRAM YOLK OF "CALIFORNIA" EGG

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7676	48	32	96	92	100	109	105	112	109	112	114	56
7714	50	25	96	101	95	104	106	106	106	109	106	56
7680 R	40	32	92	94	110	94	112	114	115	110	116	56
7681 L	38	33	89	94	102	83	80	76D				33
7679	41	33	92	95	100	106	113	111	109	112	113	56
7717 Bs	44	27	88	86	80	96	106	103	107	108	104	56
7785 R	47	24	94	100	114	115	113	98D				31
7749 RR	41	30	91	100	106	100	107	85D				35
Average	45.6	29.5	92.5	95.3	100.9	100.9	105.5	100.6	108.6	110.2	110.6	47
Average - live wt.			92.5	95.3	100.9	100.9	105.5	111.2	108.6	110.2	110.6	

D - died.

TABLE VIII

RATS ON VITAMIN A-FREE DIET PLUS 0.02 GRAM YOLK OF "KANSAS" EGG

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7756	49	23	90	101	109	117	124	119	116	86D		49
7677 Rs	41	35	104	107	106	98	101	107	104	104	76D	68
7678 L	38	34	96	92	90	91	86D					21
7751 R	38	21	87	98	112	108	99D					37
7758	51	25	96	106	117	118	126	124	118	99D		45
7783 LRR	50	24	103	111	120	117	105	100D				31
7682 B	37	33	80	99	104	106	112	119	116	116	112	56
7716 L	40	28	80	79	88	73	71D					32
7732 R	39	26	87	92	90	93	93	97	99D			38
7739	36	27	81	90	82	81	80	70	69	70	69	56
Average	42.8	27.4	92.0	96.5	101.8	100.2	99.7	105.1	102.5	95.0	85.6	41
Average - live wt.			92.0	96.5	101.8	100.2	105.9	106.0	102.8	100.0	90.5	

D - died.

TABLE IX

RATS ON VITAMIN A-FREE DIET PLUS 0.03 GRAM YOLK OF "KANSAS" EGG

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7642	46	23	87	112	107	101	100	100	104	107	100	56
7644 L	43	25	79	89	91	89	93	89	89	88	90	56
7645 B	41	23	78	89	84	88	91	81	91	95	99	56
7647 RR	40	25	89	90	90	95	93	83	101	103	102	56
7628 ♀	50	36	94	84	103	106	109	115	117	117	118	56
7588 R	49	31	90	97	104	115	107	111	110	111	113	56
7589 L	46	32	93	99	105	118	108	116	114	120	127	56
7610 R	50	24	95	106	115	113	115	113	113	114	118	56
7590 B	40	29	85	91	92	96	96	98	98	96	100	56
7596 R	40	33	101	104	110	106	111	114	116	116	122	56
7639 L	37	27	80	84	98	95	96	96	100	102	94	56
7683 RR	35	31	78	92	97	85	90	90	97	100	100	56
Average	43.3	28.3	87.4	94.7	99.7	100.6	100.7	100.8	103.1	106.4	108.4	56
Average - live wt.			87.4	94.7	99.7	100.6	100.7	100.8	103.1	106.4	106.9	

D - died.

weights. In all cases, the value of body weights obtained after death was questioned, because an animal remaining in the cage some hours after death unavoidably lost much weight by evaporation before the situation was observed. These data were studied according to the suggestions of Sherman and Munnell (11), one unit of vitamin A being the amount required to produce 3 grams of gain in body weight per week during an 8-week period. The theories of Coward (16) were also applied, namely, that results obtained after 5 or even 3 weeks of feeding may be used.

The "standard" egg, fed in portions of 0.01 gram of yolk per day, supplied less than 1 unit of vitamin A, for few of the animals survived the 8-week period. These rats exhibited the usual signs of vitamin A deficiency, including paralysis in the hind legs, xerophthalmia and emaciation. The next portion, 0.02 gram of yolk per day, also supplied less than 1 unit. The animals were in appreciably better condition than those receiving the smaller portion. In most cases they were able to survive the 8-week period of the experiment. The animals receiving 0.03 gram daily made better growth, the average figures for live body weights approaching closely the Sherman and Munnell (11) standard for 1 unit of vitamin A. This indicates that the yolk of the "standard" egg contained about 30 units of vitamin A per

gram.

The "Light" egg, fed in portions of 0.02 gram of yolk per day, supplied much less than 1 unit of vitamin A, although many of the animals survived the 8-week period. At the beginning of the experiment all animals made small regular gains, leading to the supposition that this group would grow according to the Sherman and Munsell (ii) standard. For this reason no other group was fed. Results for this group must therefore be expressed in terms of results obtained by feeding various amounts of other egg yolk, namely that 0.02 gram "Light" egg yolk contains about the same vitamin A content as 0.01 gram "Standard" egg yolk.

"Extra" egg, fed in portions of 0.02 gram of yolk per day, supplied less than 1 unit of vitamin A. Two animals survived the experimental period. The next amount, 0.03 gram, enabled the animals to make small regular weekly gains. All survived the experimental period. The total average gains for the 8 weeks was nearly 29 grams which approaches closely the standard of Sherman and Munsell. Therefore, 0.03 gram yolk supplies nearly 1 unit of vitamin A and 1 gram contains nearly 33 units of vitamin A.

Rat rats fed 0.01 gram of "California" egg yolk daily made small weekly gains at the beginning of the experiment and lived through the greater part of the 8-week period.

The average survival was 46 days. Animals receiving 0.06 gram per day made better gains and more frequently survived through the entire 8 week period. Averages for the live weights indicate that these animals were receiving nearly 1 unit of vitamin A per day. The yolk of the "California" egg therefore contained a little more than 20 units of vitamin A per gram.

The vitamin A content of the yolks of the eggs may be compared as follows:

1. The yolk of the "Standard" egg contained the largest amount of vitamin A, about 30 units per gram.

2. The yolk of the "Kansas" egg contained nearly 30 units per gram, as the average gains after 3 weeks and after 8 weeks (Coward, 16) were slightly greater, although the average gain for the entire 8-week period was less, for the same daily portion of 0.03 gram.

3. The "California" egg contained between 20 and 25 units of vitamin A per gram of yolk, as 0.04 gram portions fed daily supply a little less than 1 unit.

4. The "Light" eggs supplied smaller amounts of vitamin A, probably about half as much as the "Standard" egg.

The "Standard" and the "Kansas" eggs contained vitamin A well in excess of the 20 units per gram of yolk suggested by Sherwood and Fraps (7) as standard. No egg tested was

as rich in vitamin A as suggested by Sherman and Smith (17) who report that "egg as a whole may be expected to contain about 15 to 20 units of vitamin A per gram; and the yolk about three times this concentration."

Table X shows data for negative control animals which were used to show that the diet was deficient in vitamin A during the course of the experiment. This procedure also served to check method, to show whether or not animals were being placed on experiment after the optimum amount of depletion. The animals lost weight rapidly, exhibited the anticipated signs of vitamin A deficiency and died after 35 days on the average.

Table XI shows data for positive controls, receiving A-free diet and also 1 gram daily portion of egg yolk, as indicated. In all cases the animals survived the entire 5-week period of the experiment and made good gains, showing that the A-free diet did not have deleterious effects in other respects.

SUMMARY AND CONCLUSIONS

"Standard" and "Light" eggs, produced at the college poultry farm, and "California" and "Kansas" eggs, purchased in the markets of New York City, were studied for vitamin A content of the yolk, according to the biological method of

TABLE X

RATS ON VITAMIN A-FREE DIET

Negative Controls

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7918 B	49	18	102	102	101	102	87D					27
7265	37	38	108	84	96	84	83D					27
7334 L	41	44	102	100	90	92	70D					22
7341 R	37	44	104	70	73	64D						17
7340	39	47	97	89	84	73D						16
7849 R	40	29	94	98	92	82	69D					25
7858 R	42	30	96	99	99	81	72D					24
7893	42	38	93	101	96	90	77D					24
7824	47	39	85	94	95	87	77D					24
Average	41.5	35.2	97.9	94.0	92.2	82.8	76.0					23
Average - live wt.			97.9	94.0	92.2	86.9						

D - died.

TABLE XI

RATS ON VITAMIN A-FREE DIET PLUS 1.00 GRAM YOLK OF "STANDARD" EGG

Positive Controls

Rat No.	Wt. at 4 weeks grams	Depletion days	Wt. at end of depletion grams	Weekly weights - grams 1	2	3	4	5	6	7	8	Survival days
7229	50	25	94	115	122	135	132	130	147	144	148	56
7268 L	41	36	106	111	132	141	146	152	154	159	162	56
7317	41	29	85	100	109	121	127	130	135	142	149	56
7343	35	45	91	105	111	113	117	126	127	129	130	56
7237	46	31	103	119	128	149	157	162	177	183	187	56
7314 L	42	25	87	102	115	127	141	153	153	163	166	56
7313	44	29	93	77	74	71	82	105	119	134	157	56
7315 R	38	29	75	104	123	156	152	163	174	176	188	56
7335 B	41	44	100	106	123	135	152	163	179	185	198	56
Average	42.0	33.0	92.2	104.1	115.2	124.0	134.0	142.9	152.2	157.2	174.1	56
Average - live wt.			92.2	104.1	115.2	124.0	134.0	142.9	152.2	157.2	174.1	

Sherman and Munsell (11). The modified Sherman and Munsell vitamin A-free diet was used with viosterol added to supply vitamin D. Young rats of suitable age and size were fed this vitamin A-free diet during the customary depletion period, after which they were placed on experiment. During the experiment they received weighed supplementary portions of the yolks of eggs to be tested. An egg to be fed was hard cooked. The yolk was then removed carefully and portions of 0.01, 0.02, 0.03 or 0.04 gram fed 6 days per week.

Composite tables were prepared from data concerning the various groups of animals. These data were studied according to Sherman and Munsell (11), one unit of vitamin A being the amount required to produce 3 grams of gain in body weight per week during an 8-week period. The theories of Coward (16) were also applied to the data.

Findings are as follows:

1. Distinct differences were found between the vitamin A contents of the yolks of the eggs used.

2. The yolk of the "Standard" egg contained about 30 units of vitamin A per gram. The yolk of the "Kansas" egg contained less vitamin A, nearly 20 units per gram. The "California" egg contained about 30-25 units per gram of yolk. The "Light" egg produced at the college poultry farm contained still less vitamin per gram of yolk, probably

about half as much as did the "Standard" egg.

3. Two lots of eggs were found to contain vitamin A well in excess of the 20 units per gram of yolk recently suggested as standard by Sherwood and Fraps (7).

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